Sept. 11, 1951 C. W. J. HEDBERG 2,567,709

ELECTRICAL PRECIPITATOR WITH DUAL DISCHARGE ELECTRODES

Filed Aug. 18, 1948 3 Sheets-Sheet 1

Fig. 1.

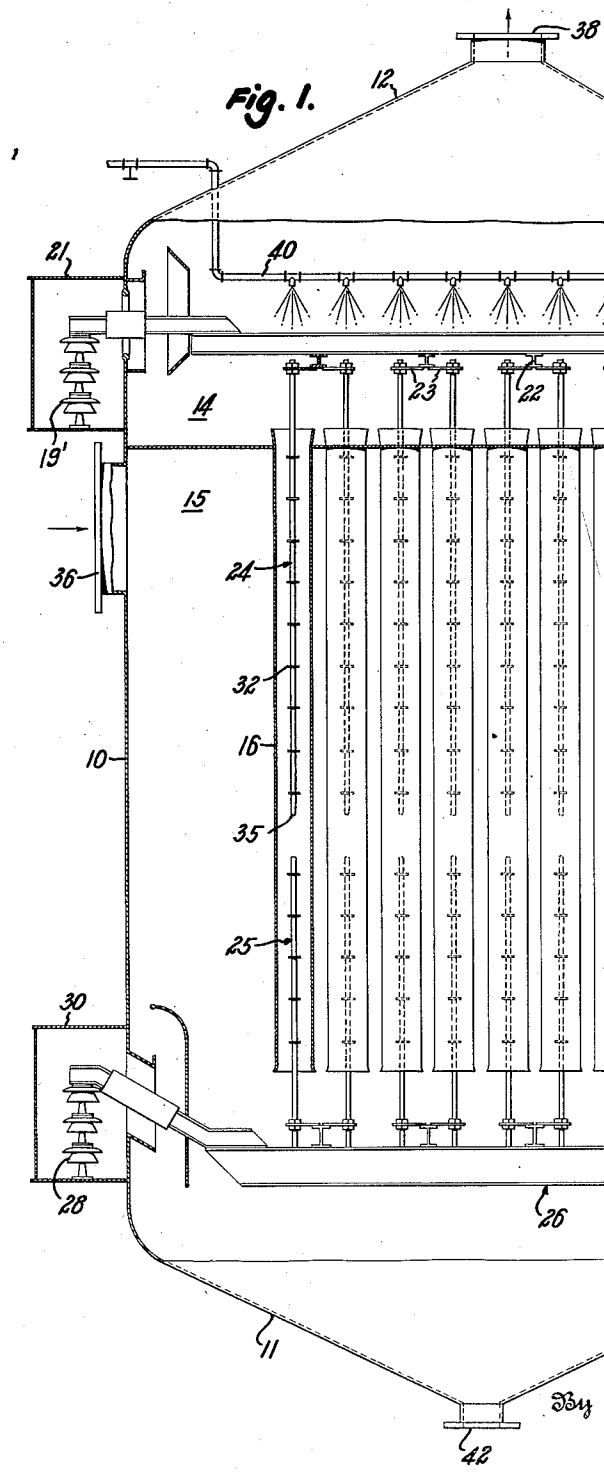


Fig. 2.

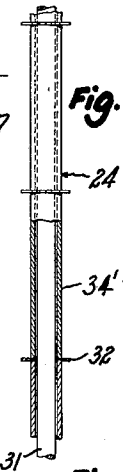


Fig. 3.



Inventor:

Carl W. J. Hedberg

By Stowell & Evans.

Attorneys.

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Fig. 4.

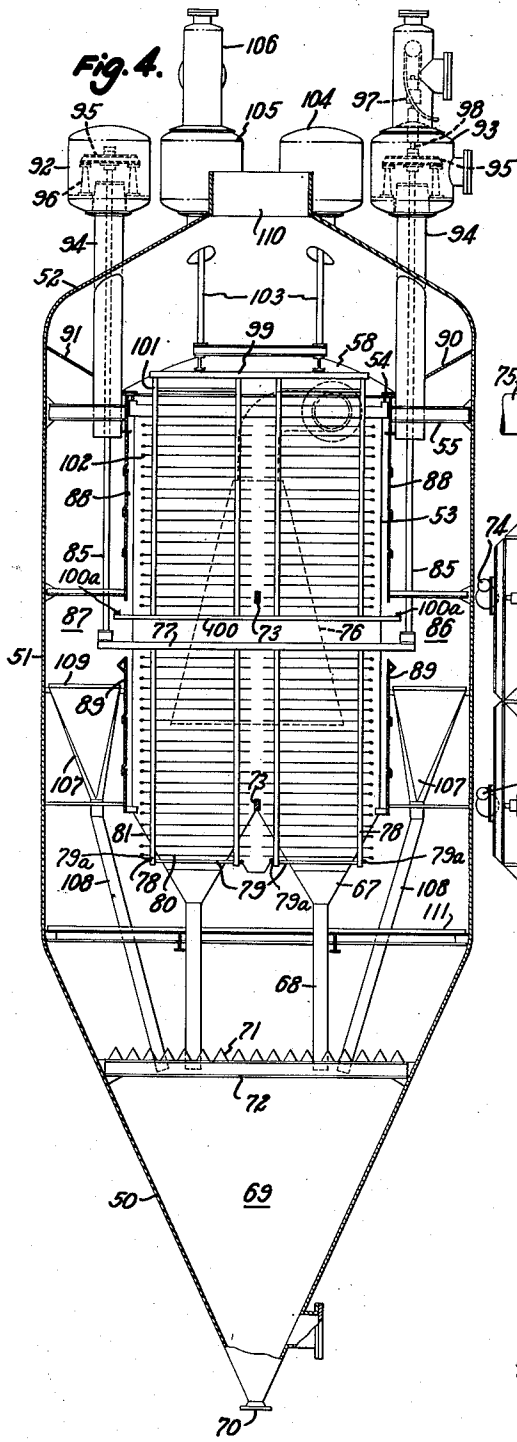
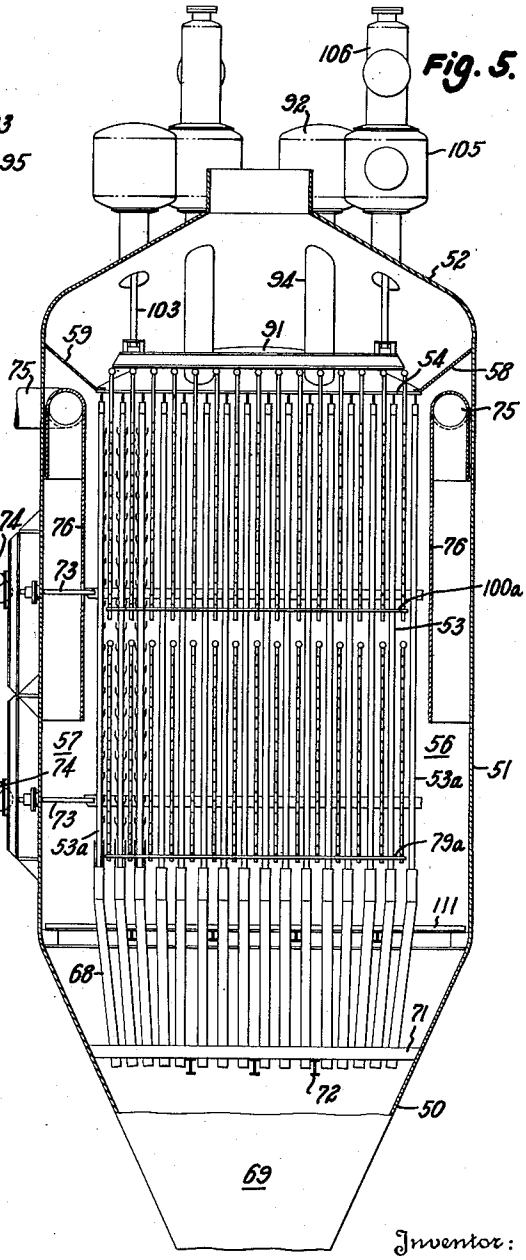


Fig. 5.



Inventor:

Carl W. J. Hedberg

By Stowell & Evans,

Attorneys.

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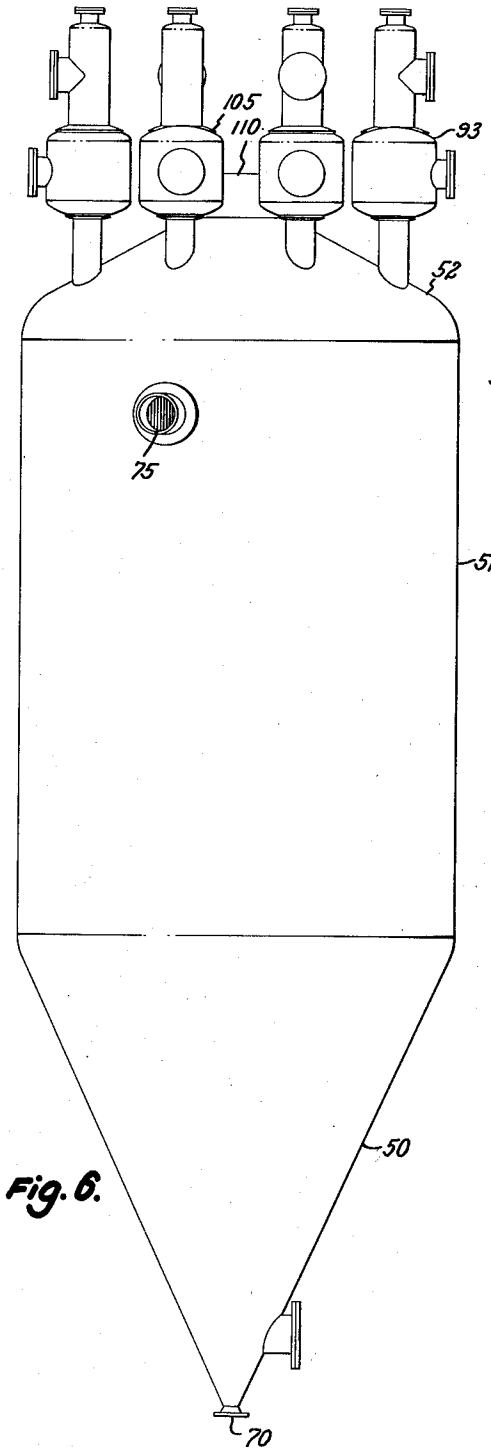


Fig. 6.

Fig. 7.

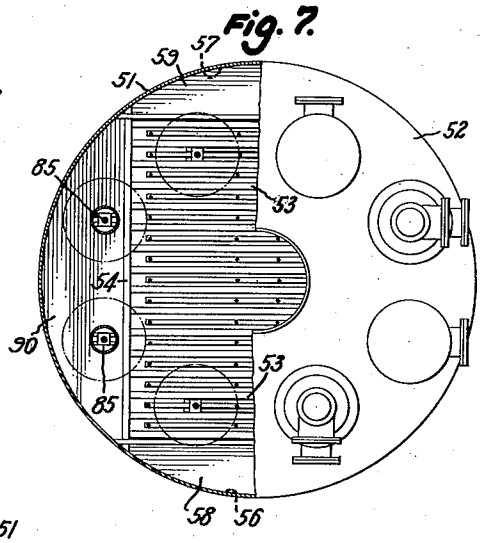


Fig. 8.

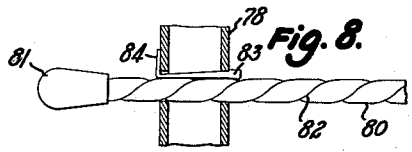
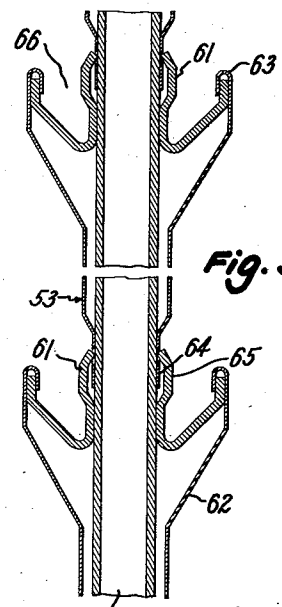


Fig. 9.



Inventor:
Carl W. J. Hedberg
By
Stowell & Evans,
Attorneys.

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UNITED STATES PATENT OFFICE

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ELECTRICAL PRECIPITATOR WITH DUAL DISCHARGE ELECTRODES

Carl W. J. Hedberg, Bound Brook, N. J., assignor to Research Corporation, New York, N. Y., a corporation of New York

Application August 18, 1948, Serial No. 44,878

6 Claims. (Cl. 183—7)

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This invention relates to electrical precipitators and more particularly to an electrical precipitator having at least two spaced sets of discharge electrodes and a single set of complementary extended surface electrodes associated therewith. Although the invention is of general application in the field of electrical precipitation, it is especially suited to precipitators that operate under superatmospheric pressure at high capacity to clean large volumes of gas bearing relatively high proportions of suspended matter.

An object of the invention is to provide an electrical precipitator particularly adapted to the cleaning of gases heavily loaded with suspended particles of clay or the like such as petroleum vapors that have been altered in composition by a catalytic cracking process in which a finely divided solid catalyst is suspended in the vapors. Such precipitators must withstand pressures of several pounds per square inch, must be leak-proof, must be capable of collecting large amounts of suspended material, must run continuously, often for months without a stop, and must efficiently clean the gases which pass through them.

Another object is to provide in a precipitator of this type support means for the collecting and discharge electrodes enabling a high voltage to be maintained between the electrodes for enhancing collection efficiency.

Another object is to provide an electrical precipitator in which the major components are so arranged in a casing that space requirements are reduced to a minimum.

Still another object is to provide an electrical precipitator in which the extended surface electrodes are readily cleaned without interrupting normal operation of the precipitator.

The foregoing and other aims, objects and advantages of the invention as may appear hereinafter are achieved in an electrical precipitator including a casing, vertically extending extended surface electrodes mounted in the casing, at least two sets of spaced discharge electrodes mounted in complementary relation to the extended surface electrodes and spaced apart in the direction of gas flow to provide spaced precipitating zones, and means for separately energizing the spaced sets of discharge electrodes. The extended surface electrodes are common to the spaced precipitating zones and provide continuous paths along which material collected in the precipitating zones is conducted to a common receiver.

In one illustrative embodiment of the invention, the extended surface electrodes take the form of parallel pipes having one set of discharge

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electrodes projecting into the pipes from one end of the assembly and another set of discharge electrodes projecting into the pipes from the other end of the assembly. Cleaning of the pipe electrodes is accomplished by flushing the surfaces thereof with a washing liquid that is introduced at one end of the pipes, flows through both precipitating zones and leaves the pipes at the other end of the assembly.

In another embodiment, the extended surface electrodes are of the parallel plate type. The plates may have internal conduits and openings leading from the plate faces into the conduits for conduction of dust from the exterior surfaces of the plates into the conduits and thence through the conduits to a dust hopper. This form of electrical precipitator may include a vertical cylindrical casing, baffle means in the casing defining an axially extending gas passage, the baffle means cooperating with the walls of the casing to define at least four peripheral zones, diaphragm means extending between the baffle means and the walls of the casing blocking flow of gas through the zones, complementary extended surface and discharge electrodes supported in the axial gas passage, the support means for the discharge electrodes extending within at least two of the peripheral zones, gas inlet means communicating with at least two other of the peripheral zones on one side of the diaphragm means, and gas outlet means on the other side of the diaphragm means.

The invention will be described with greater particularity with reference to the accompanying drawings in which:

Fig. 1 is a vertical sectional view of one form of precipitator embodying the invention;

Fig. 2 is a fragmentary partly sectional view on an enlarged scale of one of the discharge electrodes of the precipitator of Fig. 1;

Fig. 3 is a plan view of one of the discharge elements of the electrode of Fig. 2;

Fig. 4 is a vertical medial sectional view of another form of precipitator in accordance with the invention;

Fig. 5 is a vertical medial sectional view of the precipitator of Fig. 4 taken at right angles thereto;

Fig. 6 is an elevational view of the precipitator shown in Figs. 4 and 5;

Fig. 7 is a plan view thereof with part of the casing broken away to show interior construction;

Fig. 8 is an enlarged fragmentary view of a joint between a discharge electrode and its supporting frame; and

Fig. 9 is an enlarged sectional view taken transversely of one of the collecting electrodes of the second form of precipitator.

Referring to Figs. 1 through 3 of the drawings, the electrical precipitator shown has a vertically extending casing including a cylindrical central portion 10 and conical bottom and top portions 11 and 12 respectively. Positioned tranversely of the casing somewhat below the top thereof is a gas impervious plate or diaphragm member 13 that is circular in horizontal extent and is welded or otherwise appropriately secured to the sidewalls of the cylindrical casing portion 10. The plate member 13 divides the casing into an upper chamber 14 and a lower chamber 15.

A plurality of parallel pipe sections 16 are supported in spaced holes formed in the plate 13, the tops of the pipe sections being flared at 17 to tightly engage the peripheries of the holes. The pipe sections depend deeply into the lower chamber 15. Each pipe section constitutes an extended surface collecting electrode of the precipitator.

The dual discharge electrode system includes an upper frame 18 supported on insulators 19 and 19' mounted in the insulator housings 20 and 21. The frame has parallel I-beams 22 extending horizontally over the rows of pipe section 16 and the I-beams carry plates 23 that are preferably welded to the beams. From these plates, discharge electrodes 24 project axially into each of the pipe sections 16 and extend downwardly thereinto for somewhat more than half the length of the pipes.

Similar discharge electrodes 25 project axially upwardly into the bottoms of the pipe sections 16 and terminate somewhat below the lower ends of electrodes 24. The lower assembly of electrodes 25 is carried by a framework 26 similar to the framework 18 described hereinbefore, the framework 26 being mounted on insulating supports 27 and 28 in housings 29 and 30.

The construction of the discharge electrodes 24 and 25 is shown in greater detail in Figs. 2 and 3. The electrode has a central core in the form of a rod 31. A plurality of discs 32, each having a central opening 33 and discharge points 34, are positioned on the rod 31 and are spaced apart lengthwise of the rod by sleeves 34'. The composite electrode structure so assembled may be welded at the unsupported end 35 to form a unitary structure.

Gas to be cleaned is led into the precipitator through diametrically opposed inlets 36 and 37. The gas flows down in the chamber 15 outside the pipes 16, reverses direction near the bottom of the precipitator and flows upwardly through the pipes into the upper chamber 14 and passes out of the apparatus through the central outlet 38.

Suspended matter carried by the gas is precipitated in two stages in the pipes 16. In operation the casing may be grounded and the lower and upper sets of discharge electrodes may be separately energized through the high tension cables 38 and 39 that are passed through holes in the insulating bushings 27*a* and 19*a* and are connected to the high tension frames 26 and 18, respectively. With the present arrangement, different types of energization may be applied to the spaced sets of discharge electrodes to secure optimum operating conditions for the particular circumstances encountered.

The suspended material carried by the gas is

precipitated upon the inner walls of the pipes 16. Continuous or intermittent flushing of the walls of the pipes is employed to keep them in clean condition. For this purpose, a spray device including a header 40 having downwardly directed nozzles 41 is positioned in the upper chamber 14 to discharge sprays of washing or flushing liquid over the area of the tops of pipes 16. It will be seen that the diaphragm plate 13 and the walls of the casing 10 adjacent thereto provide a reservoir for the reception of flushing liquid which rises in the reservoir to the level of the upper rims of pipes 16 and spills thereover to flow down the inner surfaces of the pipes and flush them free from adherent precipitate.

The flushing liquid falls from the pipes 16 into the sump provided by the lower casing section 11 and is withdrawn therefrom through the outlet 42.

It will thus be seen that the collecting electrodes extend continuously through both precipitating sections of the precipitator and provide continuous paths along which precipitated material is conducted to the sump. Because of separate energization of the two serially arranged precipitating sections, most efficient precipitating conditions can be maintained in each section.

Referring to Figs. 4 through 9 of the drawings, the form of precipitator shown therein has a vertical casing including a conical bottom portion 50, a cylindrical central portion 51, and a conical top 52 having relatively gently sloping sides.

The collecting and discharge electrode assemblies are arranged centrally of the cylindrical section of the casing to define a central vertical gas passageway having a substantially square horizontal cross-section, the corners of which passageway are contiguous with the walls of the shell and the sides of which form, in cooperation with the walls of tre shell, four vertically extending peripheral zones having segmental cross-sections. These segmental zones provide gas inlet and distributing channels and compartments for electrode support members, as will appear more fully hereinafter.

The collecting electrodes, generally designated by the reference numeral 53, are preferably of the type sometimes referred to in the art as "tulip" electrodes. The collecting electrode assembly includes a plurality of vertically extending, horizontally spaced, parallel plate members 62 that are hung from vertical members 60 which in turn depend from horizontal beams 54 supported by cantilever members 55 carried by the walls of the shell. The outer collecting electrodes 53*a* have plane surfaces adjacent the inner walls of the shell portion 51 which form in effect vertical baffles defining two of the four segmental zones 56 and 57. In order to simplify the drawings, some of the plate electrodes 53 included between the outer plates 53*a* are shown as having plane surfaces, but it will be understood that such electrodes are of the tulip type to be described in greater detail hereinafter. Diaphragm plates 58 and 59 extend between the walls of the shell section 51 and the collecting electrode support structure to seal off the tops of zones 56 and 57 and thus to prevent flow of gas through these zones into chamber 52.

As shown in Fig. 9, the collecting electrode structure 53 has vertically extending hanger rods 60, that are U-shaped in horizontal cross-section, to which are welded at vertically spaced intervals

hook supports 61. The section of Fig. 9 is taken through one of the hangers, a plurality of which are positioned in parallel arrangement to form an open framework for the electrode structure. Upon this framework, the outer plates 62, which extend horizontally across each face of the electrode, are secured by bending the top, outwardly flared edges of the plates as at 63 to engage the free ends of hooks 61 and securing the bottom edges 64 of the plates under the fingers 65 of subjacent hooks 61. The structure so formed presents a substantially plane vertical face having horizontal slots 66 extending thereacross. The slots face upwardly to receive dust dislodged from the plates as by rapping and to direct the dust to the hollow interior of the electrode structure and thence down through the interior to the inwardly converging lower portions 67 of the electrodes, and finally through the dust chutes 68 into the dust hopper 69 at the bottom of the shell. Dust is withdrawn from the hopper 69 through the outlet 70 as necessary. The dust hopper is partitioned from the rest of the apparatus by a grating of angle irons 71 supported by I-beams 72.

The collecting electrodes may be rapped periodically for the purpose of loosening adherent dust and assisting its passage to the hopper 69. Rapper bars 73 extend through and are connected to the collecting electrodes 53, as best seen in Fig. 5. The ends of the bars are connected to rappers 74 and transmit vibrations produced thereby to the collecting electrodes.

Gas to be cleaned is admitted to the precipitator through opposed gas inlets 75 and carried downwardly in the zones 56 and 57 through downwardly flaring distributors 76 and is discharged into the lower portions of the zones.

The precipitator is provided with two vertically spaced sets of discharge electrodes arranged in complementary relation to the collecting electrodes. As seen in Fig. 4, the lower set of discharge electrodes is carried by a frame including upper cross members 77, vertical hangers 78, and lower cross members 79. Longitudinal tie rods 79a join together the ends of the lower cross members 79 and provide substantial bracing for the lower discharge electrode assembly. Horizontal discharge elements 80 are carried by the hangers 78. The discharge elements have bulbous or rounded ends 81 facing outwardly to minimize undesired corona discharge therefrom.

As shown in detail in Fig. 8, the discharge elements 80 are formed of twisted square rods providing helically disposed sharp discharge edges 82. The twisted rods are retained in the hangers 78 by wedges 83 clinched at 84 to hold them in place. Conveniently, horse-shoe nails are used as wedges.

Referring to Fig. 4, it is seen that the lower discharge electrode structure is suspended by means of the support members 85 that are attached to the upper cross members 77 of the frame and extend vertically upward through the segmental zones 86 and 87 that are complementary to the zones 56 and 57 hereinbefore described. Zones 86 and 87 are defined between the vertical baffles 88 and 89, that substantially cover the open end area of the assembly of collecting electrodes 53, and the adjacent side walls of the shell portion 51. Segmental diaphragm plates 90 and 91 are positioned across the tops of the zones 86 and 87 and effectively seal off these zones against circulation of gas therethrough. The vertical separation of baffles 88 and 89 provides

openings through which the frame members 77 extend into the segmental zones 86 and 87.

Insulator housings 92 and 93 are positioned above the precipitator shell and are mounted on tubular supports 94 that pass through openings in the casing top 52 and downwardly through holes in the baffles 90 and 91 and terminate in the segmental zones 86 and 87 near the upper ends thereof. Supports 85 for the lower discharge electrode assembly pass upwardly through the tubes 94 and are anchored to bus bars 95 supported on insulators 96 in the housings 92 and 93.

It will be understood that the lower discharge electrode assembly is energized through an electrical cable passing through a suitable bushing in the housing 92 or 93 and connected to either of the bus bars 95, for example, and that the casing and collecting electrodes are grounded in a typical installation.

A rapping mechanism for the lower discharge electrode assembly includes electrical vibrators 97 insulatedly supported over diametrically opposed support members 85. The support members 85 are preferably tubular, and vibration transmitting rods 98 extend through the tubes 85 from the vibrators 97 to the horizontal frame members 77 for the purpose of conducting vibrations therebetween. The vibrators are operated from time to time to loosen dust that may accumulate on the lower discharge electrode assembly.

An upper discharge electrode assembly, generally similar to the lower discharge electrode assembly hereinbefore described, is mounted in complementary relation to the upper section of the collecting electrode assembly. The upper assembly includes the horizontal frame members 99 and 100 and the vertical frame members 101 that support the discharge electrodes 102 that are like the discharge electrodes 80 previously described. The rods 100a are secured to the outer ends of the lower horizontal frame members 100 to brace the discharge electrode assembly. It will be seen that the tie rods 100a are positioned in the segmental zones 86 and 87 where ample space is available to locate and apply these members easily and accurately. Support members 103 suspend the assembly from insulated supports in the insulator compartments 104 and 105, as described hereinbefore in connection with the lower electrode assembly. Rappers may be provided in the insulator compartment extensions 106 for dislodging dust from the upper discharge electrode assembly. Separate energizing means preferably is provided for the upper discharge electrode assembly.

Dust collecting hoppers 107 are positioned in the lower sections of the segmental zones 86 and 87 and have dust chutes 108 for conveying dust from the hoppers 107 to the central dust receiver 69. The hoppers 107 have upwardly facing mouths 109 substantially coextensive with the cross-sectional areas of the segmental zones 86 and 87 and effectively block circulation of gas through the lower sections of these zones.

A central gas outlet 110 is located in the top section 52 of the casing.

In operation, the electrodes of the precipitator are energized from conventional power sources (not shown) and gas burdened with particulate suspended material is forced into the gas inlet conduits 75. The gas flows downwardly through the flaring distributors 76 and issues into the lower portions of segmental zones 56 and 57. A perforated gas distributing plate 111 is hori-

zontally disposed across the casing below the precipitating zones. By virtue of the shape of the casing and the positioning of the baffles and gas distributing plate therein, the gas streams flow down through the perforated plate 111 and converge towards the vertical axis of the precipitator in the zone intermediate the plate 111 and the grating 71. The gas streams merge with each other and are diverted upwardly to flow through the perforated plate 111 and through the central precipitating zones in which they are substantially relieved of their burden of suspended material. The cleaned gases issue from the top of the precipitator through the outlet conduit 110.

The bulk of the precipitated dust accumulates on the collecting electrodes 53. These electrodes are rapped as occasion demands by the rappers 74 and the loosened dust falls through the slots 66 into the interior of the collecting electrodes and passes down through the electrodes and the dust chutes 68 into the receiver 69.

The discharge electrode structures may also be rapped from time to time by the vibrators 97. Any dust that accumulates on the walls of the segmental zones 86 and 87, when loosened by action of the vibrators or by incidental action, falls into the hoppers 107 and is conducted through the chutes 108 to the receiver 69.

From the foregoing description it will be seen that the present invention provides a precipitator that can be operated for long periods of time at high efficiency to clean gases under superatmospheric pressure carrying heavy burdens of suspended matter. The construction including plural precipitating zones having collecting electrodes common to two or more zones enables the collecting electrodes to provide continuous channels for the removal of dust from the commonly served precipitating zones.

In the form of the invention of Figs. 4–7, the arrangement of and the means for mounting the plate electrodes in a cylindrical casing and the effective utilization of space for gas distribution and for mounting the discharge electrode assemblies contribute to the economical production of an electrical precipitator for treating gases under superatmospheric pressure.

I claim:

1. An electrical precipitator comprising a vertical cylindrical casing, baffle means in said casing defining an axially extending gas passage, said baffle means cooperating with the walls of said casing to define at least four peripheral zones, diaphragm means extending between said baffle means and the walls of said casing blocking flow of gas through said zones, extended surface collecting electrodes supported in said axial gas passage, an assembly of complementary discharge electrodes disposed in spaced relation to said extended surface electrodes, support means for said discharge electrodes extending within at least two of said peripheral zones, gas inlet means communicating with at least two other of said peripheral zones on one side of said diaphragm means, and gas outlet means on the other side of said diaphragm means.

2. An electrical precipitator as defined in claim 1 including insulator housings positioned on the top of said casing and communicating with the peripheral zones in which the support means for said discharge electrodes extend, insulators in said housings, and means anchoring said support means to said insulators.

3. An electrical precipitator comprising a vertical cylindrical casing, baffle means in said casing defining an axially extending gas passage, said baffle means cooperating with the walls of said casing to define four peripheral zones, diaphragm means extending between said baffle means and the walls of said casing blocking flow of gas through said zones, horizontally spaced, vertically extending, parallel plate collecting electrodes supported in said gas passage, a set of discharge electrodes disposed in complementary relation to a lower section of said collecting electrode structure, support means for said set of discharge electrodes extending within two of said peripheral zones, a second set of discharge electrodes disposed in complementary relation to an upper section of said collecting electrode structure, support means for said second set of discharge electrodes, insulator housings positioned on the top of said casing and communicating with said casing, insulators in said housings, means anchoring said discharge electrode support means to said insulators, gas inlet means for supply of gas to the other two of said peripheral zones below said diaphragm means, gas outlet means for conducting gas from said casing above said diaphragm means, and means for separately energizing said sets of discharge electrodes.

4. An electrical precipitator as defined in claim 3 wherein said parallel plate collecting electrodes have hollow interiors and are provided with upwardly facing parallel slots leading from the exterior to the interior thereof and including a dust receiver and conduits conveying dust from the interiors of said collecting electrodes to said receiver.

5. An electrical precipitator comprising a casing, a lower precipitating chamber including complementary precipitating and collecting electrodes mounted in said casing, an upper precipitating chamber including complementary precipitating and collecting electrodes mounted in said casing above said first electrodes, means for passing gas to be cleaned through said precipitating chambers, means for energizing said electrodes, a receiver mounted below said lower precipitating chamber and communicating with said lower precipitating chamber for the passage of precipitated material from said lower chamber to said receiver, and means including substantially enclosed conduit means for conducting precipitated material from said upper precipitating chamber through said lower precipitating chamber to said receiver in a stream substantially shielded from the flow of gas and the electric field in said lower precipitating chamber.

6. An electrical precipitator comprising a vertical casing, baffle means in said casing defining an axially extending gas passage, said baffle means cooperating with the walls of said casing to define at least two peripheral zones, diaphragm means extending between said baffle means and the walls of said casing blocking flow of gas through said zones, vertically extending extended surface collecting electrodes supported in said axial gas passage, a set of complementary precipitating electrodes mounted in precipitating relation to the upper portions of said collecting electrodes, insulated supports in said peripheral zones, a second set of complementary precipitating electrodes carried by said supports and mounted in precipitating relation to the lower portions of said collecting electrodes, gas inlet means communicating with at least one of said peripheral zones on one side of said diaphragm

means, gas outlet means on the other side of said diaphragm means, means for energizing said electrodes, a receiver formed in the lower portion of said casing below said electrodes, and conduit means for conducting precipitated material from the upper portions of said collecting electrodes to said receiver through the lower portion of said axially extending gas passage in a stream substantially isolated from the flow of gas and the electric field in the lower portion of said axially extending gas passage.

CARL W. J. HEDBERG.

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